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DESCRIPTION

LIQUID CRYSTAL DEVICE AND MANUFACTURING METHOD THEREOF

Technical Field

The present invention relates to a liquid crystal device and a manufacturing method thereof. The present invention particularly relates to a structure of a terrace area comprising wiring lines pulled out of a liquid crystal seal area.

Background Art

Conventional liquid crystal devices are constructed by bonding a pair of transparent substrates to one another via a seal member, and sealing a liquid crystal between the substrates inside of the seal member, or within a liquid crystal seal area.

One example of the structure of the liquid crystal devices is shown in Figs. 31(a) and 31(b). Fig. 31(a) is a planar perspective view illustrating the planar structure of the liquid crystal device **1**, and Fig. 31(b) is an enlarged cross section illustrating the structure in the vicinity of a terrace area **11s** in the liquid crystal device **1**. The liquid crystal device **10** comprises two sheet of transparent substrates **11** and **12** bonded to one

another via a seal member **13**. The transparent substrate **11** is formed to be slightly wider than the transparent substrate **12**, and a terrace area **11a** that protrudes at the side of the end portion of the transparent substrate **12** is formed on the transparent substrate **11**. The inside of the seal member **13** serves as a rectangular liquid crystal seal area **A**.

Transparent electrodes **111** are formed within the liquid crystal seal area **A** on the transparent substrate **11**, and wiring lines **131a** are pulled out on the surface of the terrace area **11a** after passing under the seal member **13**. An insulation film **112** is formed on the transparent electrodes **111** by being restricted only on the liquid crystal seal area **A**, and an orientation film **112** is additionally formed thereon. Transparent electrodes **121** are formed on the transparent substrate **12**, and these transparent electrodes **121** extend toward the area where the seal member **13** is formed, after extending toward the direction perpendicular to the transparent electrodes **111**. An orientation film **123** is formed on the transparent electrodes **121**, and a liquid crystal (not shown) injected between the orientation films **113** and **123** are controlled to be in a prescribed orientation state depending on the surface state of the orientation films.

Wiring lines **131b** are formed with a given pattern at

the right and left sides of the wiring lines **131a** on the terrace area **11a**. The wiring lines **131b** extend on the transparent substrate **11** toward the area where the seal member **13** is formed. The seal member **13** is made of a material containing conductive particles in a resin, which displays anisotropic conductivity that shows electrical conductivity only along the direction of thickness of the substrate (the direction along the gap between the substrates) by being compressed between the transparent substrates **11** and **12**. The transparent electrodes **121** overlap over the wiring lines **131b** at a vertical-conductive crossover **13b** of the seal member **13**, and the transparent electrodes are conductively connected to the wiring lines via the vertical-conductive crossover **13b**.

The tips of the wiring lines **131a** and **131b** are conductively connected to output terminals (not shown) of a driver IC **133** for addressing the liquid crystal via the anisotropic conductive film (not shown). A terminal pattern **134** is also formed on the terrace area **11a**. One end of the terminal pattern **134** is conductively connected to the input terminals of the driver IC **133** via the anisotropic conductive film, and the other end of the terminal pattern **134** is condutively connected to a wiring member **136** such as a flexible wiring substrate or a TAB substrate.

Since the wiring lines **131a** and **131b** formed on the terrace area **11a** have a small wiring width and formed with a fine pitch, they are susceptible to dust and acid besides involving a possibility to cause electric shock, the entire packaging face of the terrace area **11a** is coated with a resin molding material **141** comprising a silicone resin after packaging the driver IC **133** and the wiring member **136**.

Since the liquid crystal device **10** has been required to be thin in accordance with yjrrecent trends of thinning and compacting electronic equipment, the thickness of the transparent substrates **11** and **12** comprising a glass are being in a trend to be thinned to comply with the foregoing requirements. However, thinning the transparent substrates **11** and **12** results in decreased strength of the substrates to make them to be easily broken, while arising a possibility that cracks are generated on the substrate particularly at the terrace area **11a** where only the transparent electrodes **11** is protruding. Since the protrusion length of the terrace area **11a** is larger in the COG (Chip On Glass) type liquid crystal device constructed by packaging the diver IC **133** on the terrace area **11a** as described above, the possibility of generating cracks at the terrace area **11a** is further increased.

Such drawbacks as described above may be solved by

preventing local accumulation of stress by supporting a wide area of the terrace area **11a** with a supporting member, when the liquid crystal device is packaged within the electronic equipment. However, since the entire packaging face of the terrace area **11a** has been covered with the resin molding material **141** in the conventional liquid crystal device, it is difficult to uniformly support a wide area of the terrace area **11a**. While supporting the liquid crystal device at the back face of the terrace area **11a** that is not covered with the resin molding material **141** may be devised, this countermeasure is contradictory to the trend of thinning and compacting as hitherto described, because the thickness of the supporting structure of the liquid crystal device is increased.

The object of the present invention for solving the foregoing problems is to provide a liquid crystal device comprising a structure by which the terrace area of the liquid crystal device can be uniformly supported.

Disclosure of Invention

In a first embodiment, the present invention provides a liquid crystal device comprising: a pair of substrates opposed to one another via a seal member; a liquid crystal sealed in the inside area of the seal member between a

pair of the substrates; electrodes formed within an inside area of the seal member of one of the pair of substrates; and an insulation film disposed on the electrode, wherein the outside area of the seal member of one of the substrate comprises a terrace area that protrudes out of the end portion of the other substrate, the terrace area comprising wiring lines connected to the electrode, and wherein at least a part of the wiring lines is coated with an insulation film made of the same material as the foregoing insulation film.

According to the liquid crystal device of the first embodiment of the present invention, a resin molding step may be eliminated besides enabling the wiring lines to be securely protected from electric shock without requiring additional manufacturing steps, by forming an insulation film on the liquid crystal seal area as well as on the surface of the terrace area so as to cover the wiring lines. In addition, since the surface of the terrace area can be flattened, the surface of the terrace area may be used for supporting the liquid crystal device or as a positioning face.

It is preferable for enhancing protective property of the wiring lines to form the insulation film so as to be continuously extended from the liquid crystal seal area to the surface of the terrace area. The insulation film

preferably serves as an overcoat layer formed within the liquid crystal seal area for preventing short circuit among the electrodes formed on the substrate due to mingled foreign substances such as dust.

The wiring lines preferably comprise an conductive connection member electrically connected to an integrated circuit or to a wiring member, and the conductive connection member is not covered with the insulation film in the first embodiment of the present invention, because an integrated circuit chip and a wiring member can be packaged on the conductive connection member.

It is also preferable in the liquid crystal device according to the first embodiment of the present invention that the wiring lines comprise an conductive connection member connected to the integrated circuit or to the wiring member, and the conductive connection member is not coated with the insulation film, because the integrated circuit chip and the wiring member may be packaged on the conductive connection member.

In the case as described above, it is desirable that an anisotropic conductive film is inserted between the conductive connection member and the integrated circuit or the wiring member, and at least the entire portion to be protected of the conductive connection member is coated with the anisotropic conductive film.

In the construction as described above, at least all the portions to be protected of the exposed wiring lines, for example the portions of the wiring lines having a small wiring pitch and wiring width, are coated with the anisotropic conductive film. Consequently, protective property may be enhanced by protecting the portion not protected with the insulation film with the anisotropic conductive film. The portions to be protected as used herein refer, for example, to the wiring lines directly pulled out of the liquid crystal seal area, and the portions not to be protected refer, for example, to the wiring lines for constructing auxiliary terminals connected only to an integrated circuit, when the wiring lines directly pulled out of the liquid crystal seal area have been once connected to the integrated circuit packaged on the terrace area. The wiring pitch and wiring width of the latter wiring lines are usually formed to be larger than those of the former wiring lines.

Preferably, in the liquid crystal display device of the first embodiment of the present invention, the conductive connection member is connected to the integrated circuit or to the wiring member via an anisotropic conductive film, and the edge of the anisotropic conductive film overlaps the insulation film. Allowing the edge of the anisotropic conductive film to

overlap the insulation film permits the wiring lines to be more securely protected, because no gaps are formed between the insulation film and the anisotropic conductive film. In addition, the possibility of generating the gaps are reduced by the overlap width at both end portions, even when the position for forming an insulation film pattern has been a little shifted from the position for coating with the anisotropic conductive film.

In the first embodiment, the present invention provides a method for manufacturing a liquid crystal device having a pair of substrates opposed to one another via a seal member, and a liquid crystal sealed in the inside area of the seal member between the pair of the substrates, one of the pair of substrates comprising a terrace area protruding out of the end portion of the other substrate, comprising the steps of: forming electrodes on one of the substrate of a pair of the substrates, and wiring lines connected to the electrode on the terrace area; and forming an insulation film covering at least a part of the electrodes and the wiring lines.

In the manufacturing method as described above, the wiring lines may comprise an conductive connection member electrically connected to an integrated circuit or to a wiring member, and the conductive connection member may

comprise no insulation film.

Preferably, the conductive connection member is connected to the integrated circuit or to the wiring member via an anisotropic conductive film, and the edge of the anisotropic conductive film overlaps the insulation film.

Preferably, a positioning mark is formed on one of the substrates, the edge of the insulation film is formed along one edge of the positioning mark, and the edge of the anisotropic conductive film is formed along the other edge of the positioning mark.

In the second embodiment, the present invention provides a liquid crystal device comprising: a pair of substrates opposed to one another via a seal member; a liquid crystal sealed in the inside area of the seal member between a pair of the substrates; electrodes formed within an inside area of the seal member of one of the pair of substrates; an overcoat layer formed on the electrode; and an orientation film formed on the insulation film, wherein the outside area of the seal member of one of the substrates comprises a terrace area protruding out of the end portion of the other substrate, the terrace area comprising wiring lines connected to the electrode, and the wiring lines comprising the overcoat layer and the orientation film formed thereon, and wherein

the entire overcoat layer is covered with the orientation film on the terrace area.

In the liquid crystal device according to the second embodiment of the present invention, the overcoat layer region covers the electrodes both on the opposed face and on the terrace area, and the entire area is covered with the orientation film. Since there remains no open surface where the overcoat layer is exposed to the outside, cloths to be used for the rubbing treatment does not make direct contact with the overcoat layer when the orientation film is subjected to a rubbing treatment. Consequently, the orientation film is not damaged with powders (dusts) arising from the shaved overcoat layer, thereby enabling dirt and flaws to be prevented from generating to consequently prevent irregular images of the liquid crystal display from occurring.

The overcoat layer may be formed of silicon oxide, titanium oxide, or a mixture containing at least one of them, and the orientation film may be formed of a polyimide resin in the method for manufacturing the liquid crystal device according to the second embodiment of the present invention.

In the second embodiment, the present invention provides a method for manufacturing a liquid crystal device having a pair of substrates opposed to one another

via a seal member, and a liquid crystal sealed in the inside area of the seal member between the pair of substrates, one of the pair of substrates comprising a terrace area protruding out of the end portion of the other substrate, comprising the steps of: forming electrodes on one of the pair of substrates , and wiring lines connected to the electrode on the terrace area; forming an overcoat layer on the electrodes and on the wiring lines; forming an orientation film on the overcoat layer; and applying a rubbing treatment to the orientation film, wherein entire overcoat layer is covered with the orientation film on the terrace area.

In the third embodiment, the present invention provides a liquid crystal device comprising: a pair of substrates opposed to one another via a seal member; electrodes formed within the inside area of the seal member of the pair of substrates; and an insulation layer formed on the electrodes of one of the pair of substrates, wherein the outside area of the seal member of one of the substrates comprises a terrace area protruding out of the end portion of the other substrate; wherein the terrace area comprises wiring lines electrically connected to the electrodes provided on the other substrate via an conductive connection member, at least a part of the wiring lines being coated with the insulation layer, and

wherein the insulation layer is formed on the area except the corresponding sites to the conductive connection member.

According to the liquid crystal device in the third embodiment of the present invention, an insulation layer is also formed on the terrace area by taking advantage of the insulation layer formed on the liquid crystal area of the substrate. Accordingly, electrolytic corrosion of the wiring lines located on the terrace area can be securely prevented from appearing, as compared with the method in which a mold material such as silicone is adhered on the terrace area after forming a liquid crystal panel. Moreover, the electrodes on one of the substrates can be securely connected to the wiring lines on the other substrate with the conductive connection member without being blocked by the insulation layer, since the conductive connection member on the substrate of the liquid crystal device comprises no insulation layer.

The insulation layer preferably contains at least either the overcoat layer covering the electrode, or the orientation film formed above the electrode.

In the forth embodiment, the present invention provides a liquid crystal device comprising: a pair of substrates opposed to one another viá a seal member; electrodes formed within the inner area of the seal member

of one of the pair of substrates; and an insulation film formed on the electrode, wherein the outside area of the seal member of one of the substrates comprises a terrace area protruding out of the end portion of the other substrate; the terrace area comprises a packaging area in which wiring lines connected to the electrodes and an outer circuit including ICs for addressing the liquid crystal device are packaged; at least a part of the wiring lines are coated with an insulating film made of the same material as the foregoing insulation film; and a mold member is disposed on the wiring lines formed between the packaging area and the seal member.

According to the liquid crystal device in the fourth embodiment of the present invention, an insulation layer is also formed on the terrace area of the substrate by taking advantage of the insulation layer formed on the liquid crystal area of the substrate. Accordingly, electrolytic corrosion of the wiring lines located on the terrace area can be securely prevented from appearing, as compared with the method in which a mold material such as silicone is adhered on the terrace area after forming a liquid crystal panel. In addition, since the insulation layer is formed on the area except the tuning-on inspection area when the insulation layer is formed on the terrace area, there is no hindrance in carrying out the

turn-on inspection after forming the insulation layer, by utilizing the turn-on inspection area, or the wiring lines exposed to the outside in the area between the IC packaging area and the seal member.

In the fourth embodiment, the present invention provides a method for manufacturing a liquid crystal device comprising a pair of substrates opposed to one another via a seal member, one of the pair of substrates comprising a terrace area protruding out of the end portion of the other substrate, comprising the steps of: forming electrodes on one of the pair of substrates, the terrace area comprising wiring lines connected to the electrode; forming an insulation film covering at least a part of the electrodes and the wiring lines; adhering one of the substrates to the other substrate; inspecting turn-on of the liquid crystal device using the wiring lines; and molding the wiring lines in the area used for the turning-on inspection.

In the fifth embodiment, the present invention provides a liquid crystal device comprising: a pair of substrates opposed to one another via a seal member; and an orientation film provided at the inner face side of one of the pair of substrates, wherein the outside area of the seal member of one of the substrates comprises a terrace area protruding out of the end portion of the

other substrate, the terrace area comprising wiring lines pulled out of the inside area of the seal member; and wherein at least a part of the wiring lines is covered with an insulation film, at least the edge of the insulation film being covered with the orientation film.

Since at least a part of the wiring lines is covered with the insulation film, and at least the edge of the insulation film is covered with the orientation film in the liquid crystal device according to the fifth embodiment of the present invention, the wiring lines are coated with the portions where the insulation film and the orientation film have been formed to protect the wiring lines from electrolytic corrosion, besides forming an approximately flat surface area. Consequently, impact resistance of the liquid crystal device may be improved by preventing the substrate from being broken without sacrificing corrosion resistance, because the terrace area may be evenly supported. The effect of the edge portion of the insulation film on orientation in the liquid crystal seal area may be reduced when the orientation film is subjected to an orientation treatment, because the orientation film is formed so as to cover the edge portion of the insulation film.

As described in the liquid crystal device according to the first to fourth embodiments, the portion coated with

the insulation film and the orientation film on the terrace area include the portion except the connection portion of the wiring member on the terrace area, in addition to the packaging area of the integrated circuit (ICs) and additionally the vertical-conductive crossover area. The electrical inspection area against the wiring lines may be sometime excluded. The portion not coated with the insulation film and the orientation film may be exposed, or may be sealed with a resin molding material.

In the liquid crystal device according to the fifth embodiment of the present invention, the inside area of the seal member of one of the substrates may comprise electrodes for applying an electric field to the liquid crystal, the orientation film being provided on the electrode, and a protective film may be provided between the electrodes and the orientation film, the protective film being made of the same material as the insulation film.

The construction as described above enables the insulation film and the protective film to be simultaneously formed. Therefore, both films may be formed merely by changing a film deposition pattern without providing any separate steps, enabling the liquid crystal device to be manufactured without any cost increment.

Preferably, the orientation film is formed so as to cover the entire insulation film in the liquid crystal device according to the fifth embodiment of the present invention.

Since the orientation film is formed so as to cover the entire insulation film, the effect of the insulation film on orientation of the liquid crystal may be further reduced.

Preferably, the terrace area comprises a positioning mark, the insulation film is formed along one of the outer edge of the positioning mark, and the orientation film is formed along the other outer edge of the positioning mark in the liquid crystal device according to the fifth embodiment of the present invention.

The construction as described above allows the positioning mark to serve for positioning of the insulation film as well as positioning of the orientation film, enabling the positional relation between the insulation film and the orientation film to be determined with high precision. In particular, the edge of the insulation film may be accurately and securely covered.

Preferably,. one of the outer edge is formed to be opposite to the other outer edge in the liquid crystal device according to the fifth embodiment of the present invention.

The insulation film and the orientation film may be more precisely deposited by positioning them relative to a pair of the parallel outer circumferences of the positioning mark in opposed relation to one another.

Preferably, the positioning mark is made of the same material as the wiring lines in the fifth embodiment of the present invention.

According to the present invention, no separate steps are required for forming the positioning mark and the wiring lines because they may be simultaneously formed, besides enabling the insulation film and the orientation film to be formed with high precision relative to the wiring pattern.

It is preferable that the terrace area not coated with the insulation film is sealed with a resin molding material in the liquid crystal device according to the fifth embodiment of the present invention.

According to the present invention, short circuit of the wiring lines may be completely prevented by sealing the terrace area not coated with the insulation film with the resin molding material, and electrical inspection of the wiring lines, packaging of ICs, and conductive connection of the wiring member can be executed without any hindrance before molding with the resin.

It is preferable in the liquid crystal device

according to the fifth embodiment of the present invention that an opening portion is provided on the insulation film and the orientation film for forming an vertical-conductive crossover between a pair of the substrates.

According to the present invention, the pattern for forming the insulation film and the orientation film is less restricted by the disposition of the vertical-conductive crossover to enable the optimum film forming pattern to be freely designed, by providing an opening portion on the insulation film and the orientation film in order to form the vertical-conductive crossover for conductively connecting the electrodes on the other substrate to the wiring lines formed on the terrace area. It is preferable in this case that the opening portion on the insulation film is formed to be a size larger than the opening portion on the orientation film, so that al the edge of the opening portion on the insulation film is covered with the orientation film. The protective film and the insulation film may be integrated to one another, and the opening portion may be formed at near the boundary between the both films, when the insulation film also serves as the protective film. Otherwise, the orientation film within the liquid crystal seal area may be integrated with the orientation film on the terrace area, and the opening portion may be formed at near the boundary between

them.

In the fifth embodiment, the present invention provides a method for manufacturing a liquid crystal device having a pair of substrates opposed to one another via a seal member, one of the pair of substrates comprising a terrace area protruding out of the end portion of the other substrate, comprising the steps of: forming electrodes on one of the pair of substrates, the terrace area comprising wiring lines connected to the electrode; forming an insulation film covering at least a part of the electrodes and the wiring lines, and forming an orientation film being on the insulation film, wherein the edge of the insulation film is covered with the orientation film on the terrace area.

According to the method for manufacturing the liquid crystal device in the fifth embodiment of the present invention, short circuit may be prevented by the portion on which the insulation film and the orientation film have been formed, besides enabling a flat surface area to be formed, since at least a part of the wiring lines are coated with the insulation film and at least the edge of the insulation film is covered with the orientation film. Consequently, the substrate is protected from being broken to improve impact resistance of the liquid crystal device without compromising corrosion resistance, since the

terrace area can be evenly supported. The effect of the edge portion of the insulation film on orientation within the liquid crystal seal area may be reduced when the orientation film is subjected to an orientation treatment, by forming the orientation film so as to cover the edge of the insulation film. Increase of the manufacturing cost may be suppressed by simultaneously forming the protective film within the liquid crystal seal area and the insulation film, and by simultaneously forming the orientation film on the liquid crystal seal region and the orientation film on the terrace area, since the films may be formed by merely changing the film deposition pattern without adding any new steps.

Preferably, the method for manufacturing the liquid crystal device according to the fifth embodiment of the present invention further comprising the step of forming a positioning mark on one of the substrates, wherein the insulation film is formed along one of the outer edges of the positioning mark, and the orientation film is formed along the other outer edge.

Brief Description of the Drawings

Fig. 1 is a schematic cross section illustrating the structure of the liquid crystal device according to the first embodiment.

Fig. 2 is an enlarged plane view schematically illustrating the surface structure of the terrace area according to the first embodiment.

Fig. 3 is an enlarged plane view schematically illustrating the insulation film formed on the surface of the terrace area according to the first embodiment.

Fig. 4 is an enlarged plane view schematically illustrating the anisotropic conductive film deposited on the surface of the terrace area according to the first embodiment.

Fig. 5 is an enlarged drawing for illustrating the location of the positioning mark according to the first embodiment.

Fig. 6 is an enlarged drawing for illustrating a variation of the positioning mark according to the first embodiment.

Fig. 7 is a partially cut-away plane view of the liquid crystal device according to the second embodiment.

Fig. 8 is a cross sectional side view showing the cross sectional structure of the main part of the liquid crystal device according to the second embodiment.

Fig. 9(a) is a plane view showing one example of the electrodes configuration formed on one of the substrates constituting the liquid crystal device according to the second embodiment.

Fig. 9(b) is a plane view showing one example of the electrodes configuration formed on the other substrate constituting the liquid crystal device in opposed relation to the substrate shown in Fig. 9(a) according to the second embodiment.

Fig. 10 is a plane view showing the insulation layer formed on the surface of the substrate of an intermediate product according to the second embodiment.

Fig. 11 is a plane view showing a seal material formed on the surface of the substrate in an intermediate product according to the second embodiment.

Fig. 12 is a process flow chart showing one embodiment of the method for manufacturing the liquid crystal device according to the second embodiment.

Fig. 13 is a perspective view of an electronic equipment according to the second, third and fourth embodiments.

Fig. 14 shows a partially cut-away plane view of the liquid crystal device according to the third embodiment.

Fig. 15 shows a cross sectional side view of the cross sectional structure of the main part of the liquid crystal device along the line II-II according to the third embodiment.

Fig. 16(a) is a plane view showing one example of the electrodes formed on one of the substrates constituting

the liquid crystal device according to the third embodiment.

Fig. 16(b) is a plane view showing one example of the electrodes formed on the other substrate constituting the liquid crystal device in opposed relation to the substrate shown in Fig. 16(a) according to the third embodiment.

Fig. 17 is a plane view showing the insulation layer formed on the surface of the substrate in an intermediate product according to the third embodiment.

Fig. 18 is a plane view showing the seal material formed on the surface of the substrate in an intermediate product according to the third embodiment.

Fig. 19 is a process flow chart showing the method for manufacturing the liquid crystal device according to the third embodiment.

Fig. 20 is a partially cut-away plane view of the liquid crystal device according to the fourth embodiment.

Fig. 21 is a cross sectional side view showing the cross sectional structure of the main part of the liquid crystal device along the line II-II according to the fourth embodiment.

Fig. 22 is a process flow chart showing the method for manufacturing the liquid crystal device according to the fourth embodiment.

Fig. 23 is a plane view showing one of the substrates

constituting the liquid crystal device according to the fourth embodiment.

Fig. 24 is a plane view showing the liquid crystal device before packaging a liquid crystal addressing IC according to the fourth embodiment.

Fig. 25(a) is a schematic perspective plane view illustrating the structure of the liquid crystal device according to the fifth embodiment.

Fig. 25(b) is a schematic cross section illustrating the vicinity of the terrace area according to the fifth embodiment.

Fig. 26 is a partially enlarged plane view partially showing the plane structure of the terrace area according to the fifth embodiment.

Fig. 27 is a perspective plane view showing a planar pattern on the transparent substrate according to the fifth embodiment.

Fig. 28(a) is an enlarged partial cross section showing the cross sectional structure on the terrace area according to the fifth embodiment.

Fig. 28(b) is an enlarged partial cross section showing the cross sectional structure on the terrace area according to the fifth embodiment.

Fig. 29(a) is a schematic perspective plane view illustrating the structure of the liquid crystal device

according to the sixth embodiment.

Fig. 29(b) is a schematic perspective plane view illustrating the planar pattern on the transparent substrate according to the sixth embodiment.

Fig. 30(a) is a schematic perspective plane view illustrating the structure of the liquid crystal device according to the seventh embodiment.

Fig. 30(b) is a schematic perspective plane view illustrating the planar pattern on the transparent substrate according to the seventh embodiment.

Fig. 31(a) is a schematic perspective plane view illustrating the structure of the conventional liquid crystal device.

Fig. 31(b) a schematic perspective plane view illustrating the structure in the vicinity of the terrace area of the conventional liquid crystal device.

Best Mode for Carrying Out the Invention

(First Embodiment)

The liquid crystal device and the method for manufacturing thereof according to the first embodiment of the present invention will be described in detail hereinafter. Fig. 1 is a schematic cross section illustrating the structure of the liquid crystal device according to the first embodiment. This structure is

basically similar to the structure of the foregoing conventional liquid crystal structure, wherein the substrates **11** and **12**, seal member **13**, liquid crystal **14**, electrodes **111** and **121**, insulation films **112** and **122**, orientation films **113** and **123**, wiring lines **131** and **134**, anisotropic conductive film **132**, and integrated circuit chip **133** are similar to those shown in Figs. 7 and 8.

The insulation film **112** formed so as to coat the electrodes **111** is pulled out of the liquid crystal seal area surrounded by the seal member **13** through under the seal member **13** onto the surface of the terrace area **11a**. The wiring lines **131** is covered with an extended formation portion **112a** of the insulation film **112** formed on the surface of the terrace area **11a** of the insulation film **112**.

Fig. 2 is a plane view showing the terrace area **11a** according to this embodiment. In this drawing, the extended formation portion **112a** of the insulation film **112** corresponds to the area marked by oblique lines extending toward the upper-right in the drawing, and covers major portions of the wiring lines **131**. This extended formation portion **112a** is formed so as to shun the area where the integrated circuit chip **133** is formed, and its vicinity. In other words, the vicinity of the connection parts are not covered with the insulation film **112** so that each of

the wiring lines **131** is put into conduction with the bump electrodes **133a** of the integrated circuit chip **133**. Each of the wiring lines **131** is conductively connected to the bump electrodes **133a** of the integrated circuit chip **133** via an anisotropic conductive film (for example, a film in which minute conductive particles (such as resin balls plated with gold) are dispersed in a thermoplastic resin) **132**, which is deposited on the portion marked by oblique lines extending toward upper-left in the drawing under the integrated circuit chip **133**. The anisotropic conductive film **132** is deposited so that its end portion overlaps the end portion of the extended formation portion **112a**.

The wiring lines **134** are left naked since they are seldom affected by electrolytic corrosion, because the wiring lines **134** has a larger line width and smaller number of terminals as compared with the wiring lines **131** as hitherto described. In addition, since the wiring lines **134** are so constructed as to be able to make a press contact with a connector (not shown) comprising an anisotropic conductive rubber, they are also left naked to enable conductive connection to be achieved. Alternatively, the wiring lines **134** may be put into conductive connection with a wiring member such as a flexible wiring substrate via the anisotropic conductive film.

The procedure for manufacturing the foregoing structure will be then described with reference to Figs. 3 and 4. In the first step, The electrode layer **111,** and wiring lines **131** and **134** as shown in Fig. 1 are formed by depositing a transparent conductive material such as ITO (Indium Tin Oxide) on the surface of the substrate **11** by a PVD method such as vacuum evaporation and sputtering and by pattering using such as a known photolithograpy . They may be selectively formed by the PVD method using a shield mask. Only the surface of the terrace area **11a** (or the surface to serve as the terrace) of the surface of the substrate **11** is illustrated in Fig. 3. Positioning marks **137, 138,** and **139** are also formed together with the electrode layer **111** and wiring lines **131** and **134** using the same material and same manufacturing method as used for forming the electrode layer and wiring lines. The positioning mark **137** defines the position of the edge of the extended formation portion **112a,** the positioning mark **138** defines the position of the edge of the anisotropic conductive film **132,** and the positioning mark **139** defines the position of the edge of the integrated circuit chip **133.** The tips of the wiring lines **131** not covered with the extended formation portion **112a** (the area not marked with the oblique lines) serve as connection terminals **131a** to be conductively connected to the bump electrodes **133a**

of the integrated circuit chip **133** via the anisotropic conductive film **132**.

In the next step, the insulation film **112** is formed within the liquid crystal seal area of the substrate **11**. The insulation film **112** is also simultaneously formed on the surface of the terrace area **11a** as the extended formation portion **112a**. The insulation film **112** is formed by the sputtering method or oxidation method of SiO_2 or TiO_2. This insulation film **112** is also formed into a prescribed pattern on the surface of the substrate **11** by patterning or by selective deposition using a shield mask. The insulation film is positioned so that the edge of the extended formation portion **112a** matches the positioning mark **137** during patterning or selective deposition. The positioning mark **137** is used in order to position the edge of the extended formation portion **112a** confronting the packaging area of the integrated circuit chip **133** in the example shown in Fig. 3. The exposure mask and the shield mask are positioned for patterning and selective deposition, respectively, by sensing the position of the positioning mark **137** in a surface image using an image processing technique known in the art after taking the surface image of the substrate **11** using a camera.

In the next step, the orientation film **113** shown in Fig. 1 is formed on the surface of the substrate **11**, and

the substrate **11** is bonded to the substrate **12** on which the electrode layer **121**, insulation film **122** and orientation film **123** have been formed via a seal member **13** as shown Fig. 1 after subjecting the orientation film **113** to an orientation treatment known in the art, followed by injecting and sealing the liquid crystal **14** to complete a liquid crystal cell. The anisotropic conductive film **132** is then deposited on the terrace area **11a** as shown in Fig. 4 by taking advantage of the positioning mark **138**. The outer edge **132b** of the anisotropic conductive film **132** is disposed at the outside of the center of the anisotropic conductive film **132** from the outer edge **112b** of the extended formation portion **112a** depending on the positional relation between the positioning marks **137** and **138**. Consequently, the edge of the anisotropic conductive film **132** overlaps the edge of the extended formation portion **112a**.

Fig. 5 illustrates the relation between the positioning marks **137** and **138**, and the edges of the extended formation portion **112a** and the anisotropic conductive film **132**. The left side circumference edge **137a** of the positioning marks **137** is set to be a reference for defining the position of the outer edge **112b** of the extended formation portion **112a**, and the left side circumference edge **138a** of the positioning mark **138** is set

to be a reference for defining the outer edge **132b** of the anisotropic conductive film **132**. Accordingly, the edge of the extended formation portion **112a** is designed so as to overlap the edge of the anisotropic conductive film **132** by a width d between the circumference edges **137a** and **138a**. This width d is determined by taking the patterning accuracy for depositing the insulation film **112** and deposition accuracy of the anisotropic conductive film **132** into consideration, and is designed not to arise a gap between the extended formation portion **112a** and the anisotropic conductive film **132**, even when the patterns and deposition sites have been shifted in a certain degree.

Fig. 6 shows an another example for forming the positioning marks. The positioning mark **137f** in this drawing is designed so that the circumference edge **137fa** of the positioning mark **137f** at the left side in the drawing defines the position of the outer edge **112b** of the extended formation portion **112a**, and the circumference edge **137fb** at the right side in the drawing defines the outer edge **132b** of the anisotropic conductive film **132**.

As hitherto described, the integrated circuit chip **133** shown in Fig. 2 is mounted on the anisotropic conductive film **132** after depositing the anisotropic conductive film **132**, and is positioned so that a plurality of the bump

electrodes **133a** of the integrated circuit chip **133** correspond to the connection terminals of the wiring lines **131** on the surface of the terrace area **11a** via the anisotropic conductive film **132**. The integrated circuit chip **133** and the terrace area **11a** are pressed to one another with a heat-compression apparatus (not shown) with simultaneous heating. The base resin of the anisotropic conductive film **132** softened by heating is compressed by the compressing force, and the conductive particles dispersed in the base resin permits the terminals of the integrated circuit chip **131** to be electrically connected to the connection terminals of the wiring lines **131**.

The conductive connection structure and heat-compression bonding method using the anisotropic conductive film is the same in direct conductive connection of wiring members to the wiring lines **131**, not only in conductive connection of the wiring lines **134** to the flexible wiring substrate **136** as the wiring member as shown in Fig. 8, or in the foregoing COG structure.

The insulation film **112** formed within the liquid crystal seal area is extended onto the terrace area **11a** in the first embodiment. In other words, the insulation film **112** formed within the liquid crystal seal area is continuous to the extended formation portion **112a** in order to enhance protected state with the insulation film, such

as prevention of electrolytic corrosion of the wiring lines. However, the insulation film **112** may be formed into mutually isolated two portions of the insulation film formed within the liquid crystal seal area, and the extended formation portion **112a** on the surface of the terrace area **11a** in the present invention.

While the insulation film **112** as an overcoat layer is formed on the surface of the terrace area **11a** in order to prevent short circuit of the liquid crystal device in the foregoing first embodiment, forming an insulation film other than the overcoat layer on the surface of the terrace area **11a** is effective as well. Otherwise, the orientation film **113** may be formed on the surface of the terrace area **11a** in place of the extended formation portion **112a**, because the orientation film **113** also has an insulating property.

While only the wiring lines **131** to be protected, of the wiring lines **131** and **134** formed on the surface of the terrace area **11a** and not coated with the extended formation portion **112a**, is completely coated with the anisotropic conductive film **132** in the first embodiment, the anisotropic conductive film **132** may be deposited so as to completely cover the wiring lines **134** as well as shown by the dotted lines in Fig. 2. This means that the anisotropic conductive film **135** is formed to be integrated

with the anisotropic conductive film **132** as shown in Fig. 8, thereby the wiring lines are completely coated with the anisotropic conductive films.

The liquid crystal device according to the present invention is not restricted to those illustrated in the drawings, but it is needless to say that various modifications are possible within a range not departing from the spirit of the present invention.

(Second Embodiment)

2-1 Example of liquid crystal device

Figs. 7 and 8 show the second embodiment of the liquid crystal device according to the present invention. This liquid crystal device **1** comprises a pair of substrates **11** and **12**, and the circumferences of them are bonded to one another with a seal member **13**. These substrates **11** and **12** are constructed by mounting various elements on virgin substrates **11a** and **12a** made of a glass or a flexible material such as a plastic.

The dimension of a gap formed between these substrates **11** and **12**, so called a cell gap, is determined to be uniform, for example about 5 μm, with a plurality of spacers **15**, and a liquid crystal **14** is sealed within the cell gap surrounded by the seal member **13**. The member denoted by the reference numeral **13a** in Fig. 7 is a liquid crystal injection port formed at a part of the seal member

13. The liquid crystal **14** is injected into the cell gap through the liquid crystal injection port **13a**, which is sealed with a resin after completing injection of the liquid crystal.

First electrodes **111** are formed on the surface at the liquid crystal side of the first substrate **11**, an overcoat layer **112** as an insulation layer is formed thereon, and an orientation film **113** is additionally formed on the overcoat layer. Second electrodes **121** are formed on the surface at the liquid crystal side of the second substrate **12** opposed to the first substrate **11**, an overcoat layer **122** is formed thereon, and an orientation film **123** is additionally formed on the overcoat layer. Polarizing plates **23a** and **23b** are adhered on the outer surfaces of the substrates **11** and **12**, respectively.

The first and second electrodes **111** and **121** are formed to be a thickness of 500 to 1500 angstroms using, for example, ITO (Indium Tin Oxide). The overcoat layers **112** and **122** are formed to be a thickness of about 600 angstroms using, for example, silicon oxide or titanium oxide. The orientation films **113** and **123** are formed to be a thickness of about 300 angstroms using, for example, a polyimide resin.

The first electrodes **111** are formed by arranging a plurality of linear patterns in parallel to one another,

while the second electrodes **121** are formed by arranging a plurality of linear patterns in parallel to one another and perpendicular to the first electrodes **111**. The points where these first electrodes **111** and the second electrodes **121** cross to form a matrix corresponding to pixels for image display.

The first substrate **11** comprises a terrace **11a** protruding out of the liquid crystal area **E** for sealing the liquid crystal **14**, or protruding out of the other substrate. The first electrodes **111** on the first substrate **11** continuously extends onto the terrace **11a** to form a wiring pattern. The second electrodes **121** on the second substrate **12** are put into conductive connection with the electrodes on the first substrate **11** via conductive materials **20** (Fig. 8) dispersed within the seal member **2**, and is pulled out onto the terrace **11a** of the substrate to form a wiring pattern.

Each electrode having a wiring line electrically connecting to both substrates on the terrace **11a** of the first substrate **11** is shown as a wiring pattern in the second embodiment. Input terminals **134** for electrically connecting to an auxiliary circuit **136** is formed as a part of the wiring lines at the periphery of the terrace **11a** on the first substrate **11**.

The electrodes **111** and **121**, and the wiring portion

131b actually contain a number of wiring lines with a very narrow spacing on the entire surface area including the cross sections of the substrates **11** and **12** in the drawings including Fig. 7 and those to be described hereinafter. However, these electrodes are illustrated with a wider spacing than the actual spacing in Fig. 7 and in the drawings thereafter for easy understanding of their structures, and a part of the electrodes are omitted in the drawing. The electrodes **111** and **121** in the liquid crystal area **E** are not always formed as linear patterns, but may be formed into appropriate patterns.

While the input terminals **134** are actually formed with a narrow and constant spacing at the terminal edge of the terrace **H** of the substrate **11**, they are illustrated with a wider spacing than the actual spacing in Fig. 7 for easy understanding of the structure, and a part of the terminals are omitted in the drawing.

A liquid crystal addressing IC **133** is adhered, or packaged, with ACF (anisotropic Conductive Film) **132** as a conductive adhesive at an appropriate site of the terrace **11a** of the substrate. The well known ACF **132** is a conductive polymer film for collective electrical continuity between a pair of terminals with anisotropic conductance, which is formed by dispersing a lot of conductive particles **132b**, for example, in a thermoplastic

or thermosetting resin. Unidirectional conductive connection between the bumps **133a** of the liquid crystal addressing IC **133** and the wiring lines **131b**, and between the bumps **133a** and the input terminals **134** are achieved by heat-compressing the terrace **111a** of the substrate and the liquid crystal addressing IC **133** with the ACF **132** inserted between them.

The light passing through selected pixels is modulated by applying a scanning voltage on each column of either the first electrodes **111** or the second electrodes **121**, and by applying a data voltage on the other electrodes based on the display image, thereby images such as letters or numerals are displayed at the outside of the substrate **11** or **12**.

In Fig. 9(a), the electrodes **111**, wiring pattern **131b** and input terminals **134** are formed on the virgin substrate **11a** constituting one of the substrate **11**. With respect to the intermediate product of the substrate **11** as shown herein, an insulation layer **110** is formed on the surface of the terrace **11a** of the substrate so as to cover the entire wiring pattern **131b** as shown in Fig. 10. This insulation layer **110** comprises a first insulation layer **112** that is simultaneously formed in forming the overcoat layer **112** on the liquid crystal area **E** of the first substrate **11**, and a second insulation layer **113** that is

simultaneously formed in forming the orientation film **113** on the liquid crystal area **E**. Preventing the wiring pattern **131** on the terrace **11a** of the substrate from being exposed to the outside with the insulation layer **112** may protect the wiring pattern **131** from electrolytic corrosion. Fig. 9(b) shows the electrodes **121** formed on the surface of the virgin substrate **12a** constituting the other substrate **12**. The overcoat layer **122** is formed on the substrate **12** shown in this drawing so as to cover the electrodes **121** formed in the liquid crystal area **E** that is an area overlapping the substrate **11**.

The overcoat layers **112** and **122** are usually formed of silicon oxide or titanium oxide that is harder than polyimide constituting the orientation films **113** and **123**. However, these overcoat layers may be shaved by an external force applied during rubbing treatment against the orientation films **113** and **123**. Consequently, the first layer **112** is shaved off by rubbing treatment when the portion, where the first insulation layer **112** that serves as the overcoat layer **112** is not coated with the second insulation layer **113**, remains on the terrace **11a** of the substrate. Shaving debris adheres as dirty stripes or unnecessarily scratches on the orientation film **113** within the liquid crystal area **E**, causing deterioration of image quality of the liquid crystal.

As a countermeasure for the adverse effect described above, the entire surface of the first insulation layer **112** made of the same material as the overcoat layer **112** is covered with the second insulation layer **113** made of the same material as the orientation film **113**. In particular, as shown in Fig. 2, the periphery of the first insulation layer **112** is completely wrapped by forming the second insulation layer **113** elongating toward the downward (toward the cross section). Completely covering the entire surface of the first insulation layer **112** with the second insulation layer **113** securely protects the first insulation layer **112** from being damaged during the rubbing treatment, thereby securely preventing image quality of the liquid crystal from being deteriorated.

The seal member **13** for bonding the first substrate **11** to the second substrate **12** is formed by screen printing so as to surround the overcoat layer **112** and orientation film **113** on the first substrate **11**, in addition to dividing them from the insulation layer **110** as shown in Fig. 11.

According to this embodiment as hitherto described, the insulation layer **110** is also formed on the terrace **11a** of the substrate **11** by taking advantage of the insulation layers formed on the liquid crystal area **E** of the first substrate **11**, or by taking advantage of the overcoat layer **112** and the orientation film **113**. Consequently, the

wiring pattern **131** located at the terrace **11a** of the substrate can be more securely shielded from the outside, as compared with coating the entire area of the terrace **11a** of the substrate with a molding material such as Si (silicon) after the liquid crystal panel has been formed, thereby permitting the wiring pattern **131** to be securely protected from electrolytic corrosion.

Displayed images of the liquid crystal may be also securely prevented from being deteriorated by protecting the first insulation layer **112** from being damaged during the rubbing treatment, by completely covering the entire surface of the first insulation layer **112** with the second insulation layer **113**.

Fig. 12 shows one embodiment of the method for manufacturing the liquid crystal device **1** shown in Fig. 7. In this manufacturing method, the first substrate **11** is formed as shown in Fig. 9(a) via the steps P1 to P4. Practically, the first electrodes **111**, wiring lines **131**, and the input terminals **134** as a part of the wiring lines are formed on the virgin substrate **11a** comprising a glass or a plastic using ITO as a starting material by a well-known patterning method such as a photolithographic method (Step P1).

Then, the overcoat layer **112** is formed by offset printing on the first electrode **111** in the liquid crystal

area **E** as shown in Fig. 10, and the first insulation layer **112** of the insulation layer **110** is simultaneously formed on the terrace **11a** leaving the input terminals **134** area and IC packaging area behind (Step P2). The orientation film **113** is further formed on the overcoat layer **112** by, for example, offset printing, and the second insulation layer **113** is simultaneously formed on the first insulation layer **112** (Step P3). The second insulation layer **113** is formed so as to completely cover the entire surface of the first insulation layer **112** including its periphery.

Then, the liquid crystal area **E** is formed as a division by forming the seal member **13** at the periphery of the virgin substrate **11a** by screen printing as shown in Fig. 11. The reference numeral **13a** denotes the liquid crystal injection port formed at a part of the seal member **13**.

Meanwhile, the second electrodes **121** are formed on the virgin substrate **12a** comprising a glass or a plastic by a well-known patterning method, for example the photolithographic method, using ITO as a starting material on the second substrate **12** as shown in Fig. 9(b) (Step P5 in Fig. 6), the overcoat layer **122** is formed thereon by offset printing (Step P6), and finally the orientation film **123** is formed on the overcoat layer by offset printing to form the second substrate **12**.

Usually, a plurality of the first substrates **11** and the second substrates **12** are simultaneously formed as described above on separate large area mother substrates. The first substrates **11** and the second substrates **12** on these mother substrates are aligned, or positioned, and are bonded to one another (Step P8) with the seal members **13** (see Fig. 7).

Then, the liquid crystal injection port **13a** (see Fig. 7) formed at a part of the seal member **13** is exposed to the outside by the primary break of the large area mother substrate (Step P9), and the liquid crystal is injected into the liquid crystal area **E** through the liquid crystal injection port **13a**, followed by sealing the liquid crystal injection port **13a** with a resin after completing injection of the liquid crystal (Step 10). A liquid crystal device **1** as shown in Fig. 7 on which the liquid crystal addressing IC **133** is not packaged is formed thereafter by secondary break (Step P11).

Then, ACF **132** (see Fig. 7) is adhered on the IC packaging area **J**, the liquid crystal addressing IC **133** is aligned thereon for temporary packaging, and is heat-compressed by pressing and heating to package the liquid crystal addressing IC **133** on the prescribed position on the substrate **11** (Step P12). The liquid crystal device **1** as shown in Fig. 7 is completed by adhering polarizing

plates **23a** and **23b** on the outer surfaces of the substrates **11** and **12** (Step P13), respectively. An auxiliary wiring substrate **136** is connected to the input terminals **134** thereafter at an appropriate timing.

2-2 Example of electronic equipment

Fig. 13 shows a portable phone as one embodiment of the present invention. The portable phone **30** shown herein comprises various constituting elements such as an antenna **31**, a speaker **32**, a liquid crystal device **40**, key switches **33**, and a microphone **34** accommodated in a package case **36** as a container. A control circuit board **37** mounting a control circuit for controlling the operation of each constituting element is provided in the package case **36**. The liquid crystal device **1** as shown in Fig. 1 may be used for the liquid crystal device **40**.

Input signals through the key switches **33** and the microphone **34**, and received data from the antenna **31** is transferred to the control circuit on the control circuit board **37** in this portable phone **30**. This control circuit then displays images such as numerals, letters and figures on the display panel of the liquid crystal device **40** based on various input data, and transmits the date out of the antenna **31**.

2-3 Application examples

While the present invention has been described above

with respect to the preferred embodiments, the present invention is not restricted to the embodiments, but various modifications are possible within the range as set forth in the claims.

For example, although the liquid crystal device shown in Fig. 7 is a COG (Chip On Glass) type liquid crystal device, or a liquid crystal device comprising a liquid crystal addressing IC directly packaged on the substrate, the present invention is also applicable to a liquid crystal device in which the liquid crystal addressing IC is not directly packaged on the substrate. While a passive matrix liquid crystal device has been assumed in Fig. 7, an active matrix type liquid crystal device may be used in place of the passive matrix liquid crystal device.

The present invention has been applied to a liquid crystal device comprising a structure in which the liquid crystal addressing IC is packaged only on one of the substrates **11** and **12**, or to a liquid crystal device comprising a structure in which the wiring pattern **131a** is formed on only one substrate, in the embodiment shown in Fig. 7. However, the present invention is also applicable to a liquid crystal device having a different structure, for example to a liquid crystal device having a structure in which the liquid crystal addressing ICs are packaged on both substrates **11** and **12**.

While the liquid crystal device according to the present invention is used in the portable phone as an electronic equipment in the embodiment shown in Fig. 13, the liquid crystal device according to the present invention may be used for other arbitrary electronic equipment such as a portable information terminal, an electronic pocketbook and a viewfinder of a video camera.

(Third Embodiment)

3-1 Examples of liquid crystal device

Figs. 14 and 15 show the third embodiment according to the present invention. This liquid crystal device **1** comprises a pair of substrates **11** and **12** in which their circumferences are bonded to one another with a seal member **13**. This seal member **13** is formed by, for example, printing. These substrates **11** and **12** are manufactured by forming various elements on virgin substrates **11a** and **12a** made of a rigid material such as a glass, or a flexible film such as a plastic.

The gap formed between these substrates **11** and **12**, or the so-called cell gap, is controlled to have a uniform width of, for example, about 5 μm with a plurality of spacers **15**, and a liquid crystal **14** is sealed within an area surrounded by the seal member **13** in the cell-gap. The reference numeral **13a** in Fig. 14 denotes a liquid crystal injection port formed at a part of the seal member

13. The liquid crystal **14** is injected into the cell-gap through the liquid crystal injection port **13a**, and the liquid crystal injection port **13a** is sealed with a resin after completing injection.

First electrodes **111** are formed on the surface at the liquid crystal side (the face opposing to the second substrate **12**) of the first substrate **11**, an overcoat layer **112** is formed thereon, and an orientation film **113** is additionally formed on the overcoat layer. Second electrodes **121** are formed on the surface at the liquid crystal side (the face opposing to the first substrate **11**) of the second substrate **12** opposed to the first substrate **11**, an overcoat layer **122** is formed thereon, and an orientation film **123** is additionally formed on the overcoat layer. Polarizing plates **23a** and **23b** are adhered on the outside surfaces of the substrates **11** and **12**, respectively.

The first and second electrodes **111** and **121** are formed as transparent electrodes made of, for example, ITO (Indium Tin Oxide) with a thickness of about 500 to 1500 angstrom. The overcoat layers **112** and **122** are made of, for example, silicon oxide, titanium oxide or a mixture thereof with a thickness of about 600 angstrom. The orientation films **113** and **123** are made of, for example, a polyimide resin with a thickness of about 300 angstrom.

The first electrodes **111** are formed by aligning a plurality of linear patterns to be in parallel relation to one another, while the second electrodes **121** are formed of a plurality of linear patterns so as to construct an area perpendicular to the first electrodes **111** aligned in parallel to one another. Plural crossing points among the first electrodes **111** and the second electrodes **121** as a dot matrix constitute pixels for image display.

The first substrate **11** comprises a liquid crystal area **E** in which the liquid crystal **14** is sealed, and a terrace **11a** expanding to the outside of the liquid crystal area **E**. In other words, the first substrate **11** protrudes out of the terminal face of the second substrate **12**, and the first electrodes **111** on the first substrate **11** continuously extend toward the terrace **11a** to form a wiring pattern. The second electrodes **121** on the second substrate **12** are made to be in electrical continuity with the electrodes on the first substrate **11** via conductive connection materials **20** (see Fig. 15) dispersed within the seal member **13**, and are extended toward the terrace **11a** of the substrate to form a wiring pattern.

Respective electrodes, which are formed on the terrace **11a** of the first substrate **11** so as to be electrically connected to respective electrodes **111** and **121** formed on the opposed faces of both substrates, are indicated as a

wiring pattern **131b**. Input terminals **134** for communicating an auxiliary circuit are formed at the terminal edge of the terrace **11a** of the first substrate **11**.

A number of the electrodes **111** and **121**, and the wiring member **131b** are actually formed with a very narrow spacing on the entire surface of the substrates **11** and **12**, respectively, in Fig. 14 and in the drawings to be described thereafter. However, these electrodes are illustrated with a wider spacing than the actual spacing in Fig. 14 and in the drawings thereafter for easy understanding of their structures, and a part of the electrodes are omitted in the drawings. The electrodes **111** and **121** in the liquid crystal area **E** are not always formed as linear patterns, but may be formed into appropriate patterns.

While the input terminals **134** are actually formed with a given narrow spacing at the terminal edge of terrace **11a** of the substrate **11**, they are illustrated with a wider spacing than the actual spacing in Fig. 14 for easy understanding of the structure, and a part of the terminals are omitted.

The liquid crystal addressing IC **133** is packaged by bonding with ACF (Anisotropic Conductive Film) **132** as a conductive adhesive at an appropriate site on the terrace

11a. This well-known ACF **132** is a conductive polymer film that is used for collective anisotropic electrical continuity between a pair of terminals, and is formed by allowing a lot of conductive particles **132b** to disperse in a resin film **132a** made of, for example, a thermoplastic or thermosetting resin. Unidirectional conductive connections between bumps **133a** of the liquid crystal addressing IC **133** and the wiring pattern **131b**, and between the bumps **133a** and the input terminals **134** are achieved, by inserting the ACF **132** between the IC package area **J** of the terrace **11a** of the substrate and the liquid crystal addressing IC **133** followed by heat-pressing them.

A pressurizing (compressing) tool is used for heating and compressing in the heat-compression step, and heating and pressing are simultaneously carried out by allowing the pressurizing (compressing) tool to contact the liquid crystal addressing IC **133** from the upward. A heater may be also placed under the terrace **H** of the substrate at the opposite side to the face on which the liquid crystal addressing IC is packaged.

A scanning voltage is applied for each column on either the first electrodes **111** or the second electrodes **122** from the packaged liquid crystal addressing IC **133**. In addition, data voltages based on display images are applied on the other electrodes, thereby the light passing

through selected pixels is modulated to display images such as letters, numerals and figures on the outside of the substrates **11** or **12**.

Fig. 16(a) shows the electrodes **111**, wiring pattern **131** and input terminals **134** formed on the surface of the virgin substrate **11a** constituting the substrate **11**. Fig. 16(b) shows the electrodes **121** formed on the surface of the virgin substrate **12a** constituting the other substrate **12**. The reference symbol **A** denotes an conductive connection part of the substrate, which allows the wiring member **131** to be electrically connected to the electrodes **121** formed on the other substrate **12a** through this conductive connection part **A**, when the substrate **11** is bonded to the other substrate **12**.

With respect to a intermediate product of the substrate **11** shown in Fig. 16, an insulation layer **110** is formed on the surface of the terrace **11a** of the substrate so as to cover the entire wiring pattern **131b** as shown in Fig. 17. This insulation layer **110** comprises a first insulation layer **112** simultaneously formed in forming the over coat layer **112** on the liquid crystal area **E** of the first substrate **11**, and the second insulation layer **1113** simultaneously formed in forming the orientation film **113** on the liquid crystal area **E**. The wiring pattern **131** is protected from electrolytic corrosion by preventing the

wiring pattern **131** on the terrace **11a** of the substrate from being exposed to the outside with the insulation layer **110**.

With respect to the other substrate **12**, the overcoat layer **122** is formed so as to cover the electrodes **121** formed on the liquid crystal area **E** that is an area overlapping the substrate **11** as a counterpart.

While the overcoat layer **122**, orientation film **123** and insulation layer **110** are formed over a wide area on the surface of the substrate **11**, they are not formed at least on the conductive connection part **A** of the substrate. The seal member **13** for bonding the first substrates **11** to the second substrate **12** is formed by screen printing, so that they surrounds the overcoat layer **112** and the orientation film **113** on the first substrates **11**, besides dividing these films from the insulation layer **110** on the terrace **11a** of the substrate, and passing through the conductive connection part **A** of the substrate. Since the conductive materials **20** (see Fig. 15) are dispersed within the seal member **13**, the conductive materials **20** can be disposed at the tip of the terminals at the liquid crystal area **E** side of the wiring member **131** by inserting the seal member **13** through the conductive connection part **A**.

The conductive materials **20** permit the electrodes **121** on the substrate **12** to be electrically connected to the

wiring pattern **131** of the terrace **11a** of the substrate **11** by being inserted between them, when the substrate **11** is bonded to the substrate **12** with the seal member **13**. However, since the insulation layer **110** is not formed on the conductive connection part **A** of the substrate, the problem that the conductive property given by the conductive materials **20** decreases by the presence of the insulation layer **110** may be solved in this embodiment.

According to the third embodiment as hitherto described, the insulation layer **110** is also formed on the terrace **11a** of the substrate **11** by taking advantage of the insulation layer formed on the liquid crystal area **E** on the first substrate **11**, or the overcoat layer **112** and the orientation film **122**. Consequently, the wiring pattern **131** formed on the terrace **11a** of the substrate may be more securely shielded from the outside, as compared with molding the entire surface of the terrace **11a** of the substrate with a molding material such as silicone after forming the liquid crystal panel, thereby allowing the wiring pattern **131** to be more securely protected from electrolytic corrosion.

Moreover, there is no possibility of decreasing the conductivity between the opposed electrodes by the conductive materials **20**, because no insulation film **110** is formed on the conductive connection part **A** even when the

insulation layer **110** is formed on the surface of the terrace **11a** of the substrate in this embodiment.

Fig. 19 shows one embodiment for manufacturing the liquid crystal device **1** shown in Fig. 14. The first substrate **11** as shown Fig. 16(a) is formed through the steps P1 to P4 in this manufacturing method. Practically, The first electrodes **111**, the wiring pattern **131** and the input terminals **134** are formed by the patterning method known in the art, for example, a photolithographic method, using ITO as a staring material on the virgin substrate **11a** comprising a glass or plastic (Step P1).

Then, the overcoat layer **112** is formed on the first electrodes **111** by offset printing on the liquid crystal area **E** as shown in Fig. 17, and the first insulation layer **112** of the insulation layer **110** is simultaneously formed on the terrace **11a** except the input terminal **134** area, IC packaging area **J** and conductive connection part **A** (Step P2). The orientation film **113** is additionally formed on the overcoat layer **112** by offset printing, and the second insulation layer **113** is simultaneously formed on the first insulation layer **112** (Step P3). The second insulation layer **113** is also formed by excluding the input terminal **134** area, IC packaging area **J** and conductive connection part **A**, as in the step for forming the first insulation layer **112**.

Then, the seal member **13** comprising the liquid crystal injection port **13a** is formed at the circumference of the virgin substrate **11a** by, for example, screen printing to divide the liquid crystal area **E** as shown in Fig. 18. The conductive materials **20** dispersed within the seal member **13** is disposed on the electrode within the conductive connection part **A** of the substrate.

With respect to the second substrate **12**, on the other hand, the second electrodes **121** are formed by, for example, the photolithographic method on the virgin substrate **12a** comprising a glass or plastic using ITO as a starting material as shown in Fig. 16(b) (Step P5 in Fig. 19). Subsequently, the overcoat layer **122** is formed on the second electrodes by, for example, offset printing (Step P6), followed by forming the orientation film **123** on the overcoat layer by offset printing, thereby completing the second substrate **12**.

Usually, the first substrate **11** and the second substrate **12** formed as described above are simultaneously formed on separate large area mother substrates (so-called mother glass substrates) as a plurality of respective substrates. The first substrates **11** and the second substrates **12** on these mother substrates are aligned, or positioned, and bonded to one another (Step P8) with the seal members **13** (see Fig. 14).

Then, the liquid crystal injection port **13a** (see Fig. 14) formed at a part of the seal member **13** is exposed to the outside by the primary break of the large area mother substrate (Step P9), and the liquid crystal is injected into the liquid crystal area **E** through the liquid crystal injection port **13a**, followed by sealing the liquid crystal injection port **13a** with a resin after completing injection of the liquid crystal (Step 10). A liquid crystal device **1** as shown in Fig. 7 on which the liquid crystal addressing IC **133** is not packaged is formed thereafter by secondary break (Step P11).

Then, the ACF **132** is adhered on the IC packaging area **J** (see Fig. 1), and the liquid crystal addressing IC **133** is temporarily packaged for alignment thereon, followed by heat-compression by heating and pressing, thereby packaging the liquid crystal addressing IC **133** on the prescribed site on the substrate **11** (Step P12). Then, the polarizing plates **23a** and **23b** are adhered on the outer surface of the substrates **11** and **12** (Step P13), respectively, to complete the liquid crystal device **1** shown in Fig. 14. An auxiliary circuit board **136** is connected to the input terminals **134** at an appropriate timing thereafter.

3-2 Examples of electronic equipment

Fig. 13 shows a portable phone as one embodiment of

the electronic equipment according to the present invention. Since the main components of the electronic equipment in this embodiment is the same as those of the electronic equipment in the second embodiment, the same drawing as used in the second embodiment is also used in this embodiment. The portable phone **30** shown herein comprises various constituting elements such as an antenna **31**, a speaker **32**, a liquid crystal device **40**, key switches **33**, and a microphone **34** accommodated in a package case **36** as a container. A control circuit board **37** mounting a control circuit for controlling the operation of each constituting element is provided in the package case **36**. The liquid crystal device **1** as shown in Fig. 1 may be used for the liquid crystal device **40**.

Input signals through the key switches **33** and the microphone **34**, and received data from the antenna **31** is transferred to the control circuit on the control circuit board **37** in this portable phone **30**. This control circuit then displays images such as numerals, letters and figures on the display panel of the liquid crystal device **40** based on various input data, and transmits the data out of the antenna **31**.

3-3 Example of applications

While the present invention has been described with reference to the preferable embodiments, the present

invention is not restricted to these embodiments, but various modifications are possible within the scope of the present invention.

For example, although the liquid crystal device shown in Fig. 14 corresponds to a COG (Chip On Glass) type liquid crystal device, or to a liquid crystal device comprising a liquid crystal addressing IC directly packaged on the substrate, the present invention is applicable to a liquid crystal device in which the liquid crystal addressing IC is not directly packaged on the substrate. While a passive matrix type liquid crystal device has been assumed in Fig. 1, an active matrix type liquid crystal device may be used in place of the passive matrix type liquid crystal device.

While the liquid crystal addressing IC has been packaged on either the substrate **11** or the substrate **12**, or the wiring pattern **131** has been formed only on one of the substrate, in the embodiment shown in Fig. 1, the present invention is applicable to liquid crystal devices having structures other than the structure as described above, for example a liquid crystal device having liquid crystal addressing ICs packaged on both substrates **11** and **12**.

While the liquid crystal device according to the present invention was used for a portable telephone as one

of the electronic equipments in the embodiment shown in Fig. 13, the liquid crystal device may be also applied for other arbitrary electronic equipments, for example a portable information terminal device, an electronic pocketbook and a viewfinder of a video-camera.

(Fourth Embodiment)

4-1 Example of liquid crystal device

Figs. 20 and 21 show a liquid crystal device according to the fourth embodiment of the present invention. This liquid crystal device **1** comprises a pair of substrates **11** and **12** in which their circumferences are bonded to one another with a seal member **13**. The seal member **13** is formed by printing. The substrates **11** and **12** comprises various elements formed on virgin substrates **11a** and **12a** made of a rigid transparent material such as a glass or a flexible transparent material such as a plastic.

The space formed between the substrates **11** and **12**, a so-called cell gap, is controlled to have a uniform width of, for example, about 5 μm with a plurality of spacers **15**, and a liquid crystal **14** is injected and sealed in the area surrounded by the seal member **13** in the cell-gap.

First electrodes **111** are formed on the surface of the liquid crystal side of the first substrate **11**, an overcoat layer **112** is formed thereon, and an orientation film **113** is additionally formed on the overcoat layer. Second

electrodes **121** are formed on the surface of the liquid crystal side of the second substrate **12** opposed to the first substrate **11**, an overcoat layer **122** is formed thereon, and an orientation film **123** is additionally formed on the overcoat layer. Polarizing plates **23a** and **23b** are adhered on the outside surface of the substrates **11** and **12**, respectively.

The first and second electrodes **111** and **121** are formed to have a thickness of about 500 to 1500 angstrom with ITO (Indium Tin Oxide), the overcoat layers **112** and **122** are formed to have a thickness of about 600 angstrom with silicon oxide, titanium oxide or a mixture thereof, and the orientation film **113** is formed to have a thickness of about 300 angstrom with a polyimide resin.

The first electrodes **111** are formed by aligning a plurality of linear patterns in parallel to one another, and the second electrodes **121** are formed by aligning a plurality of linear patterns in parallel to one another and perpendicular to the first electrodes **111**. Pixels for image display are formed at plural crossing points where these electrodes **111** and **121** cross to one another and form a dot matrix.

The first substrate **11** comprises a liquid crystal area **E** in which the liquid crystal **14** is sealed, and a terrace **11a** expanding out of the liquid crystal area **E**. The first

electrodes **111** on the first substrate **11** is directly extended toward the terrace **11a** to form a wiring pattern. The second electrodes **121** on the second substrate **12** is put into conductive connection with the electrodes on the first substrate **11** via the conductive material 20 (Fig. 21) dispersed inside the seal member 13, and is extended toward the terrace **11a** to form a wiring pattern. Respective electrodes formed into wiring patterns by being put into conductive connection from both substrates to the terrace **11a** of the first substrate **11** are shown as extension electrodes **131** in this embodiment. Output terminals **134** for electrically connecting to an auxiliary circuit is formed at the terminal edge of the terrace **11a** of the first substrate **11**. Fig. 21 shows a cross section along the line II-II in Fig. 20. An insulation layer **110** drawn on the input terminals **134** in Fig. 21 denotes an insulation layer formed at the back of the area where the input terminals **134** are formed, and the insulation layer **110** is not formed on the input terminals **134**.

In Fig. 20 and in the drawings to be described hereinafter, a number of the electrodes **111**and **121**, and the wiring lines **131** are actually formed on the entire surfaces of the substrates **11** and **12** with a narrow spacing. However, these electrodes are illustrated in Fig. 20 with a wider spacing than the actual spacing for

easy understanding of the structure, and a part of the electrodes are omitted in the drawing. The electrodes **111** and **121** are not always formed as linear lines, but they may be formed into appropriate patterns. While the input terminals **134** are actually formed at the terminal edge of the terrace **11a** of the substrate **11** with a prescribed narrow spacing, they are illustrated with a wider spacing than the actual spacing in Fig. 20 for easy understanding of the structure, and a part of the terminals are omitted in the drawing.

The terrace **11a** of the substrate **11** comprises a turn-on inspection area **T** as an area for allowing an electrical continuity inspection apparatus such as a probe to contact for the turn-on inspection, a IC packaging area **J** for adhering, or packaging, the liquid crystal addressing IC **133**, and an input terminal area **N** for connecting the auxiliary circuit board **136**. The turn-on inspection area **T** on the terrace **11a** is provided at a site adjoining to a step formed between the terrace and the second substrate **12** by protruding the first substrate **11**, or at the site between the seal member and the IC packaging area. The insulation layer **110** is formed on the area except the turn-on inspection area **T**, IC packaging area **J** and the input terminal area **N** on the terrace **11a**.

The insulation layer **110** comprises a first layer **112**

simultaneously formed in forming the overcoat layer **112** on the liquid crystal area **E**, and a second layer **113** simultaneously formed in forming the orientation film **113** on the liquid crystal area **E**, of the first substrate **11**. The insulation layer 110 permits the wiring patterns **131** on the terrace **11a** to be protected from being exposed to the outside, thereby preventing the extension electrodes **131** from electrolytic corrosion.

The turn-on inspection area **T** serves as an area for inspecting the display quality of the liquid crystal device by tentatively turning the pixels within the liquid crystal area **E** on. When the liquid crystal device has been decided to pass the turn-on test after finishing the turn-on inspection, the liquid crystal addressing IC is heat-compressed onto the terrace **11a** of the substrate.

The heat-compression step of the liquid crystal addressing IC **133** comprises adhering, or packaging, the liquid crystal addressing IC **133** on the terrace **11a** of the substrate with an ACF (Anisotropic Conductive Film) as a conductive adhesive. The well known ACF is a conductive polymer film used for collective conductive connection between a pair of terminals, and is manufactured by allowing a number of conductive particles **132b** to disperse in a thermoplastic or thermosetting resin film **132a**. A unidirectional conductive connection is achieved between

bumps **133a** of the liquid crystal addressing IC **133** and the wiring pattern **131**,and the bumps **133a** and the input terminals **134**, by inserting the ACF **132** between the IC packaging area **J** on the terrace **11a** of the substrate and the liquid crystal addressing IC **133**, followed by heat-compressing them together. A pressurizing (compressing) tool (not shown) is used for heating and pressing in the heat-compression step, and heating and pressing is simultaneously carried out by allowing the pressurizing (compressing) tool to contact the liquid crystal addressing IC **133** from the upward. A heater may be also placed under the terrace **H** of the substrate at the opposite side to the face on which the liquid crystal addressing IC is packaged.

A scanning voltage is applied for each column on either the first electrodes **111** or the second electrodes **122** with the packaged liquid crystal addressing IC **133**. In addition, data voltages based on display images are applied on the other electrodes, thereby the light passing through selected pixels is modulated to display images such as letters, numerals and figures on the outside of the substrates **11** or **12**.

After heat-compression of the liquid crystal addressing IC **133**, a molding step is applied to the turn-on inspection area **T**. A moisture-proof molding material

141 such as an insulation silicone is applied by coating on the turn-on inspection area **T**. This molding material **141** also permits the wiring pattern **131** to be protected from being exposed to the outside, thereby preventing the extension electrodes **131** from electrolytic corrosion.

The wiring pattern **131** of the turn-on inspection area **T**, as well as the electrodes **121**, can be simultaneously coated by applying the molding material **141** on the turn-on inspection area **T**, wherein the electrodes **121** is exposed to the open air as a result of penetration of the substrate **12** through the seal member **13** due to the errors in the molding accuracy of the seal member **13** and assembling accuracy of the substrates **11** and **12**.

The entire wiring pattern **131** and input terminals **134** formed on the terrace **11a** of the substrate are protected from being exposed to the outside, by applying the molding material **141** on the turn-on inspection area **T** in addition to electrically connecting the auxiliary wiring board **136** to the input terminal area **N** with the ACF or a heat seal, thereby the wiring pattern **131** can be securely prevented from electrolytic corrosion.

According to the embodiment as hitherto described, the insulation layer **110** is also formed on the terrace **11a** of the substrate **11** by taking advantage of the insulation layer formed on the liquid crystal area **E** of the first

substrate **11**, or by taking advantage of the overcoat layer **112** and the orientation film **113**. Consequently, the liquid crystal device may be efficiently manufactured since there is no need of waiting a large amount of the molding material covering the entire area of the terrace **11a** of the substrate to cure for a long period of time, as compared with the case when the entire area of the terrace **11a** of the substrate is covered with a molding material such as silicone after forming the conventional liquid crystal panel. Moreover, the wiring pattern **131** located on the terrace **11a** of the substrate may be more securely protected from electrolytic corrosion.

In addition, since the insulation layer **110** is formed on the area except the turn-on inspection area **T** in forming the insulation layer **110** on the terrace **11a** of the substrate, the turn-on inspection after forming the insulation layer **110** may be carried out without any hindrance by taking advantage of the wiring pattern **131** exposed to the outside on the turn-on inspection area **T**.

Fig. 22 shows one embodiment for manufacturing the liquid crystal device **1** shown in Fig. 20. In this manufacturing method, the first substrate **11** is manufactured through the steps P1 to P4 as shown in Fig. 23. Actually, the first electrodes **111** and the wiring pattern **131** are formed on a virgin substrate **11a**

comprising a glass or a plastic by a well-known patterning method, for example by a photolithographic method, using ITO as a starting material (Step P1).

The overcoat layer **112** is formed on the first electrodes **111** on the liquid crystal area **E** by, for example, offset printing, and the first layer **112** of the insulation layer **110** is simultaneously formed on the terrace **11a** except the turn-on inspection area **T**, the IC package area **J** and the input terminal area **N** (Step P2). Then, the orientation film **113** is formed on the overcoat layer **112** by offset printing, and the second layer **113** is simultaneously formed on the first layer **112** of the insulation layer (Step P3). Subsequently, the seal member **13** is formed at the periphery of the virgin substrate **11a** by screen printing to divide the liquid crystal seal area **E**. The reference numeral **13a** denotes a liquid crystal injection port formed at a part of the seal member **13**.

With respect to the second substrate **12**, on the other hand, the second electrodes **121** are formed by a well-known patterning method, for example by the photolithographic method, on the virgin substrate **12a** (see Fig. 21) comprising a glass or a plastic using ITO as a starting material (Step P5 in Fig. 22). Then, the overcoat layer **122** is formed thereon by offset printing (Step P6), and the orientation film **123** is formed on the overcoat layer

by offset printing, thereby completing the second substrate **12**.

Usually, the first substrate **11** and the second substrate formed **12** formed as described above are simultaneously formed on separate large area mother substrates (so-called mother glass substrates) as a plurality of respective substrates. The first substrates **11** and the second substrates **12** on these mother substrates are aligned, or positioned, and bonded to one another (Step P8) with the seal members **13** (see Fig. 20).

Then, the liquid crystal injection port **13a** (see Fig. 20) formed at a part of the seal member **13** is exposed to the outside by the primary break of the large area mother substrate (Step P9), and the liquid crystal is injected into the liquid crystal area **E** through the liquid crystal injection port **13a**, followed by sealing the liquid crystal injection port **13a** with a resin after completing injection of the liquid crystal (Step 10). A liquid crystal panel corresponding to one liquid crystal device **1** as shown in Fig. 24, on which the turn-on inspection area **T**, the IC package area **J** and the input terminal area **N** are open to the outside without being covered with the insulation layer, is formed by the secondary break (Step P11).

Subsequently, a prove of an inspection apparatus is made to contact the wiring pattern **131** exposed to the

outside at the turn-on inspection area **T**, and a given magnitude of an addressing electric current is applied to each electrode through the prove to tentatively turn each pixel within the liquid crystal area **E** on for inspecting the quality of the pixels (Step P12). When the inspection results are normal, then the ACF **132** (see Fig. 20) is adhered on the IC packaging area **J** (see Fig. 20), and the liquid crystal addressing IC **133** is temporarily packaged with alignment followed by heat-compressing by pressing and heating, thereby the liquid crystal addressing IC **133** is packaged on the prescribed site on the substrate **11** (Step P13).

Subsequently, the molding material **141** such as Si is adhered by coating on the turn-on inspection area **T** after inspection (Step P14). Polarizing plates **23a** and **23b** are additionally adhered on the outside surface of the substrate **11** and **12** (Step P15), respectively, thereby completing the liquid crystal device **1** shown in Fig. 20. Although the input terminal area **N** is open to the outside yet, it can be also shielded from the outside atmosphere by electrically connecting an auxiliary wiring board **16** to the input terminals **12** at an appropriate timing thereafter.

The entire area of the wiring pattern **131** on the terrace **11a** of the substrate **11** is shielded from the

outside atmosphere by the procedure described above, and consequently the extension electrodes **131** is securely protected from electrolytic corrosion. According to this embodiment, in particular, since the layer formed by the molding treatment, which has slightly lower moisture-proof property as compared with the layers such as the insulation layer **110** formed by deposition methods including the photolithographic method, is applied on a very limited area, the function for preventing electrolytic corrosion may be maintained for a long period of time at a high level.

4-2 Example of Electronic Equipments

Fig. 13 shows a portable phone as one embodiment of the electronic equipments according to the present invention. The same drawings as used in the second embodiment are also used in this embodiment, since the same main components in this embodiment are common to those used in the second embodiment. The portable phone **30** shown herein comprises various constituting elements such as an antenna **31**, a speaker **32**, a liquid crystal device **40**, key switches **33**, and a microphone **34** accommodated in a package case **36**. A control circuit board **37** mounting a control circuit for controlling the operation of each constituting element is provided in the package case **36**. The liquid crystal device **1** as shown in

Fig. 1 may be used for the liquid crystal device **40**.

Input signals through the key switches **33** and the microphone **34**, and received data from the antenna **31** is transferred to the control circuit on the control circuit board **37** in this portable phone **30**. This control circuit then displays images such as numerals, letters and figures on the display panel of the liquid crystal device **40** based on various input data, and transmits the data out of the antenna **31**.

4-3 Examples of application

While the present invention has been described with reference to the preferred embodiments, the present invention is not restricted to these embodiments, but various modifications are possible within the scope of the present invention as set forth in the claims.

While the insulation layer **110** is formed with two layers of the first and second insulation layers **112** and **113** in the embodiments shown in Figs. 20 and 21, the insulation layer **110** may be formed using one of these insulation layers.

The insulation layer was formed on the area except the turn-on inspection area **T**, the IC packaging area **J** and the input terminal area **N** in the fourth embodiment. However, since the IC package area is not provided on the substrate in the liquid crystal device in which the liquid crystal

addressing IC is not directly packaged on the substrate, or in the liquid crystal device other than the COG type liquid crystal device, the IC package area is not included in the area not provided with the insulation layer in the latter case.

The present invention was applied to the liquid crystal device in which the liquid crystal addressing IC is packaged only on one of the substrates **11** and **12**, or to the liquid crystal device in which the wiring pattern **131** is formed on only one substrate, in Fig. 20. However, the present invention is applicable to the liquid crystals other than those as described above, for example a liquid crystal device in which the liquid crystal addressing IC is packaged on both the substrates **11** and **12**. While a passive matrix type liquid crystal device has been assumed in Fig. 20, an active matrix type liquid crystal may be used in place of the passive matrix type liquid crystal device.

While the liquid crystal device according to the present invention was used for the portable phone as an electronic equipment, the liquid crystal device according to the present invention may be used for other arbitrary electronic equipments such as a portable information terminal, an electronic pocketbook and a viewfinder of a video camera.

(Fifth Embodiment)

The schematic perspective plane view, and the schematic enlarged cross section in the vicinity of the terrace area of the liquid crystal device according to the fifth embodiment of the present invention are shown in Figs. 5(a) and 5(b), respectively.

While transparent electrodes **111**, wiring lines **131a** and **131b**, and a terminal pattern (input terminals) **134** have been simultaneously formed on a transparent substrate **11** using the same material such as ITO (Indium Tin Oxide) by sputtering, one pair each of positioning marks **21,22** and **23** are also simultaneously formed on the surface of the substrate using the same material as used in the above members. All the positioning marks **21,22** and **23** are formed into rectangular shapes in this embodiment.

A protective film (an insulation film) **112**, which is called as a top-coat layer or an overcoat layer, is formed in a liquid crystal seal area **A** over the elements on the surface of the substrate **11** by a lithographic method, sputtering method or oxidation method using an insulation material such as SiO_2, Si_3N_4 and TiO_2. The outer edge at the terrace area **11a** side of the protective film **15** is positioned so as to match the outer edge close to the liquid crystal seal area **A** on the positioning mark **21**.

A pair of insulation films **112** are formed on the

surface of the terrace area **11a** simultaneously with forming the protective film **112** using the same material as the protective film. The outer edges of the insulation films **112** are formed so as to align the outer edge at the side a distance apart from the liquid crystal seal area **A** at the positioning mark **22**, and the outer edge at the side a distance apart from the driver IC **133** package area at the positioning mark **23**, respectively.

Then, a polyimide resin or a polyalcohol resin is further coated on the protective film **122** and the insulation film **122** to form an orientation film **113** on the liquid crystal seal area **A** after firing. The outer edge at the terrace area **11a** side of the orientation film **113** is formed so as to climb over toward the terrace area **11a** side as shown in Fig. 26. The orientation film **113** is positioned so that its outer edge aligns the outer edge at the terrace area **11a** side of the positioning mark **21**.

The orientation film **113** is also formed on the insulation film **112** which is formed on the terrace area **11a** simultaneously with forming the orientation film **113** using the same material. This orientation film **133** is also formed so as to expand out of the outer edge of the insulation film **112** as shown in Fig. 26. In other words, the orientation film **113** is formed so that its outer edge aligns the outer edge at the liquid crystal seal area **A**

side at the positioning mark **22**, and aligns the outer edge at the driver IC **133** package area side at the positioning mark **23**. The orientation film **113** is subjected to rubbing treatment, and endowed with a required orientation property suitable for the liquid crystal.

The planar configuration of the transparent electrodes **111**, wiring lines **131a** and **131b**, terminal pattern **134**, protective film **112** and orientation film **113** formed on the transparent substrate **11** as described above are shown in Fig. 27. As shown in Fig. 27, the area mainly comprises the liquid crystal seal area **A** on which the protective film **112** and orientation film **113** are formed, and the area on the terrace **11a** are formed with a distance apart to one another. This is because the area for electrically connecting the wiring lines **131b** to the transparent electrode **121** formed on the transparent substrate **12** through a vertical-conductive crossover member **20**, and the area for making contact with the prove for electrical inspection, should be secured as will be described hereinafter. The insulation film **112** and the orientation film **113** are formed to be divided to the left and right to one another on the terrace area **11a**. This is because the area for packaging the driver IC **133** and the area for connecting the wiring member **136** should be secured as will be described hereinafter.

Then, the seal member **13** and the vertical- conductive crossover member **20** are coated on the transparent substrate **11** to form a plane using a dispenser. The seal member **13** is different from the conventional one, but comprises an insulation resin not containing conductive particles, and may contain insulation spacers. The vertical-conductive crossover member **20** comprises anisotropic conductive material containing conductive particles as in the conventional one. The transparent substrate **12**, on which the transparent electrodes **121** and orientation film **123** are formed, is adhered to the transparent substrate **11** as shown in Fig. 25(b), and the bonded substrates are pressurized so that it has a prescribed thickness. The transparent electrodes **121** is conductively connected to the wiring lines **131b** via the vertical-conductive crossover member **20** in this embodiment by bonding the two substrates.

The liquid crystal is injected thereafter into the liquid crystal seal area **A** using a conventional method, and is sealed with a sealing material **19**. Subsequently, the driver IC **133** is packaged and the wiring member **134** is connected, and a molding material **141** is coated on the area denoted by oblique lines (dotted oblique lines) shown in Fig. 25(a) for sealing. Since the portions to be provided with the insulation film **112** and the orientation

film **113** are not required to be coated with the molding material **141**, they remain without being coated with any molding material **141**, and maintained to be flat. The outer edge of the molding material **141** is formed so as to extend on the orientation film **113**, and so that the orientation film **113** overlaps molding material **141** at their boundary to one another as shown in Fig. 26 in this embodiment.

The driver IC **133** is packaged via an anisotropic conductive film (ACF, not shown) adhered at the edge of the wiring lines **131a** and **131b** in this embodiment. Accordingly, the portion covered with this anisotropic conductive film is not required to be coated with the resin mod material **141**, when the portion not covered with the orientation film **113** is covered with the anisotropic conductive film. The entire wiring area of the terrace area **11a** not covered with the orientation film **113** may be covered merely with the anisotropic conductive film. However, since it is usually impossible to cover the wiring lines **131b** in the vicinity of the terminal edge with the anisotropic conductive film, the exposed wiring area is protected by using the anisotropic conductive film and the resin molding material **141** together.

The wiring lines **131a** and **131b** are exposed between the outer edge at the seal member **13** side of the insulation

film **112** and the orientation film **113** in the terrace area **11a**, and the edge of the transparent substrate **12**, in the manufacturing method in this embodiment. Electrical inspection is carried out against the exposed portion at an appropriate timing before coating the resin molding material **141**.

Since a flat surface covered with the insulation film **112** and orientation film **113** is formed at a part of the terrace area **11a** in this embodiment, the liquid crystal device may be supported using this flat surface while maintaining corrosion resistance of the wiring lines **131a** and **131b**, making it possible to reduce breakage of the substrate.

A dense portion **112a** is liable to be formed at the outer edge as shown in Figs. 28(a) and 28(b), when the insulation film **112** and orientation film **113** are formed by the lithographic method. Consequently, the outer edge of the insulation film **112** is rubbed with a part of a rubbing cloth (mostly used by being secured on a roller) making contact with the dense portion **112a** during the rubbing treatment, or the orientation film **113** is affected at the portion shaded by the dense portion **112a**, when the outer edge of the insulation film **112** is exposed without being covered with the orientation film **113**, thereby the image quality may be deteriorated by poor orientation of the

orientation film **113**. However, since the orientation film **113** covers at least a part of the edge of the insulation film **113** in this embodiment, the dense portion **112a** is covered with the orientation film to avoid poor orientation as described above from occurring. The construction of this embodiment as described above is valid when the insulation film **112** is formed by a method other than lithographic printing, because the edge of the insulation film **112** is readily affected by the rubbing treatment when it is exposed.

Since all the edges (the outer edge and inner edge) of the insulation film **112** on the transparent substrate **11** is in particular covered with the orientation film **113** in this embodiment, poor orientation as described above may be more perfectly prevented.

(Sixth Embodiment)

The sixth embodiment according to the present invention will be described in detail hereinafter with reference to Fig. 29. Since this embodiment is constructed to be approximately the same as the fifth embodiment, the same or corresponding members are assigned by the same reference numerals, and explanations of the same members are omitted.

The orientation film **113** centered on the liquid crystal seal region **A**, and the insulation film **112** and the

orientation film **113** formed on the terrace area **11a** are continuously integrated on the transparent substrate **11** in this embodiment. The packaging area of the driver IC **133** and the connection area of the wiring member **134** are so configured as to expose the wiring lines **131a** and **131b**, and the terminal pattern **134** in this embodiment as in the foregoing embodiments.

Opening portions **112a** and **113a** are formed on the insulation film **112** and orientation film **113**, respectively, in order to permit the wiring lines **131b** to be conductively connected to the transparent electrode **121** via the vertical-conductive crossover member **20** in this embodiment. The opening portion **112a** is formed to be a little larger than the opening portion **113a** in order to allow the formed to completely envelop the latter. Accordingly, the opening portion of the insulation film **112** is completely covered with the orientation film **113**.

The insulation film **112** may be also positioned with the orientation film **113** by taking advantage of the positioning mark **23** in this embodiment, wherein the insulation film and the orientation film are formed so as to circumvent the packaging areas for the IC driver **133** and the wiring member **134**. Otherwise, the insulation film **112** may be positioned with the orientation film **113** so that the outer edge of the wiring lines **131a**, or the edges

of the opening portions **112a** and **113a**, are aligned with both side edges of the positioning mark **24**.

The terrace area **11a** may be completely sealed by coating the resin molding material **141** on the packaging area of the driver IC **133** and the wiring member **136**, after packaging the driver IC **133** and electrically connecting the wiring member **134**. Alternately, only the exposed portions having fine wiring pitches and susceptible to short circuit may be sealed with the resin molding material **141**.

(Seventh Embodiment)

The seventh embodiment of the present invention according to the present invention will be described in detail hereinafter with reference to Fig. 30. The same or corresponding members are also assigned by the same reference numerals, and explanations of the same members are omitted in this embodiment.

Conductive particles (for example, metal particles or resin particles on the surface of which an electrical conductive film (a film plated with Ni-Al) is formed) are dispersed in a resin as a seal member **13**, and a conductive member, or an anisotropic conductive member, having conductivity only along the direction of thickness of the substrate (along the gap direction between the substrates) is formed by bonding a transparent substrate **11** to

transparent electrodes **12** via the seal member **13** in this embodiment as in the conventional example shown in Fig. 31. Wiring lines **131b** formed on the transparent substrate **11** are put into conductive connection with the transparent electrodes **121** formed on the transparent substrate **12** via a vertical-conductive crossover member **13b**.

An insulation layer **112** and an orientation film **113** are also formed in this embodiment as in the sixth embodiment. An opening portion **112a** for assuring conductive connection between the electrodes and wiring lines is formed on the insulation film **112**, and an opening portion **113a** formed to be a little larger so as to completely envelope the opening portion **112a** is formed on the orientation film **113**. Accordingly, since the edge of the insulation film **112** is completely covered with the orientation film **113**, irregular rubbing at the opening portion of the insulation film **112** can be prevented during the rubbing step of the orientation film **113**.

The packaging area of the driver IC **133**, and the conductive connection area of the wiring member **136** may be also sealed with a resin molding material **141** in this embodiment, after packaging the driver IC **133** and electrically connecting the wiring member **136**. Alternately, only the exposed portions having fine wiring pitches and susceptible to electrical shock may be sealed

with the resin molding material **141**.

The liquid crystal device and the method for manufacturing thereof according to the present invention is not restricted to the embodiments exemplified by the drawings, but various modifications are possible within the range not departing from the spirit of the present invention.